united on the banks of the Niger, where they still now have some of their brethren bearing the same name in its primitive form—Ioûrâghen. Political events occurring about two centuries ago, compelled that tribe to emigrate, and the Ioûrâghen, leaving the comparatively rich country that extends between Timbuktou and Gôgo, sought for a new home in the barren grounds of central Sahara. On their arrival in the country of Azjer, they found the inhabitants, Touâreg like themselves, under the merciless tyranny of the reigning sultan of the Imanân, who thought it feasible to treat the new comers as he treated his subjects, that is to reduce free or noble men to the condition of serfs. A struggle ensued, which I have related in my book, and it ended in the complete defeat of the despotic sultan. After that event the supremacy of the Imanân ceased, and the chief of that tribe remained simply a chief, without any effective authority over the others, but still continuing to bear the vain title of a king. The power now passed, except for the Imanghasâten, into the hands of the head men of the Orâghen.

Such a complicated state of things could only be understood after a long stay—as mine was—among the Touâreg; and no blame is due to former travellers, most of them English, who, in their hasty journeys, could not detect the real value of the title of the so-called sultan of the northern Touâreg. In fact, the first English travellers coming from Fezzân must have been impressed on that point with notions derived from the sympathies of the inhabitants of that country for the Imanân and the Imanghasâten. But in another respect these very sympathies sometimes create enmities, and always distrust, between the Orâghen and their party, and the Arab allies of the Imanân living in Fezzân. I am still convinced that the lamentable assassination of poor Miss Alexine Tinné and her companions is to be accounted for by the occult contrivances of the followers of the religious sect of Sîdi es-Senoûsi, availing themselves of the opportunity of the outbreak of a civil war among the Touâreg.

After this long digression, let us now return to the work done by Commander Mircher and his fellow-travellers. Starting from Ghadâmès, they crossed, in a north-westerly direction, the region of the sand-hills, touching at the well of Ghardâya, on the same road as Captain de Bonnemain, and they came through Wâd Soûf to the town of Biskra, in Algeria.

In a scientific point of view, M. Vatonne's part of the work in that mission is most important. Not only did he constantly aid Captain de Polignac in surveying the routes, and to a larger extent in taking the plan of the oasis of the Ghadâmès, but his narrative is very substantial, and it deserves to be recommended especially to students of geology.*

In this review I have been enabled only to give a general, though, I trust, an intelligible account of the progress of discovery south of Algeria.

HENRY DUVEYRIER.

* The work containing the results of that mission is—*Mission de Ghadâmès. Rapports officiels.* Alger., 8vo., 1863.

THE GULF-STREAM.

IN his admirable work *The Depths of the Sea*, Professor C. Wyville Thomson has devoted a chapter to the Gulf-stream, in which the author tells his readers (page 385) that it seems to him, as it did to Sir John Herschel, "that the Gulf-stream is the one natural physical phenomenon on the surface of the earth, whose origin and principal cause, the drift of the trade-winds, can be most clearly and easily traced."

It is undeniable that the names of such philosophers as Sir John Herschel and Mr. Wyville Thomson give great weight to their assertions, but not so great, I would submit, as to oblige us to accept their opinions without proof. In the fifty pages which Mr. Wyville Thomson has written about the Gulf-stream, I expected to find, not an assertion only, but also a demonstration that the trade-winds are indeed the principal cause of this wonderful current. Instead of that, we have been favoured with the reasons why he does not agree with the opinions of his colleague, Dr. Carpenter, or with those of Maury and others, who do not think that the principal cause of the Gulf-stream can be most clearly and easily traced, and certainly not to the drift of the trade-winds.

Mr. Wyville Thomson says (page 365), "It is not easy to understand Captain Maury's views." Unfortunately we have to deplore the great loss of my lamented friend; he is no more among us to enlighten Mr. Wyville Thomson on what may appear to him difficult to understand in Maury's clear and precise writing. I will therefore submit a few observations to assist Mr. Wyville Thomson in expelling the clouds which, from his point of view, appear to hang over Maury's hypothesis about the origin of the Gulf-stream. To do this I will use Maury's own words:—

"But before I go further, I wish to announce a rule of conduct by which I have been guided from the commencement of this work, and by which I mean to be guided to the end; for not only has experience proved it wise, but it is in principle so good that to it I attribute much of the success which has attended these labours. This rule has been to keep the mind unbiassed by theories and speculations; never to have any wish that an investigation would result in favour of this view in preference to that, and never to attempt by premature speculations to anticipate the results of investigation, but always to trust to the observations."

"After these have been discussed, until the phenomena they conceal have been sufficiently developed, or developed as far as the materials on hand were capable of developing them, then, and not till then, has an explanation been sought. The plan has been, first the fact, and then the cause; and in seeking to account for any one fact, though several explanations may present themselves, that one is preferred which, besides satisfying the case in hand, will serve also to explain the greatest number of other known facts. In truth, these investigations have been strict investigations for facts, with the full conviction that facts, when grouped together in sufficient numbers, and catechised with reverence, will themselves reveal their cause, or place in our hands the clue to such explanation as man is permitted to comprehend."*

In this last sentence the whole mystery of Maury's

* Maury's *Sailing Directions.*

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system of research is revealed. Not only the careful observations of the selected few, but facts grouped together in sufficient numbers and catechised with reverence by a mind unbiassed by theories and speculations. He starts not with a theory of his own, nor adopts any existing theory, but he collect facts. Thousands and thousands of observations of the trade-winds, and as much as can be gathered about the currents in the sea, are collected and grouped, and catechised with reverence, expecting that they themselves will reveal their cause, or place in our hands the clue to such explanation as man is permitted to comprehend. By so doing he did not find that the trade-winds could be the principal cause of the Gulf-stream, and to get more and better facts, from which he expected the revelation he was looking for, he suggested an hypothesis. Let us hear his own words again; I wish we could hear them from his own lips:—

"In some cases an hypothesis is not only wholesome in its bearings, but necessary to progress. When I have deemed such to be the case, I have felt it my duty to offer an hypothesis. But whenever in this work I have ventured an hypothesis, it has been for the purpose of stimulating observers or thinkers, expecting thus to make a step towards some hidden truth, by proving the hypothesis wrong, or by proving it right, for in either case there is generally a triumph and a step gained."

In this spirit the hypothesis about the principal cause of the Gulf-stream was offered by Maury, to which I do not think full justice has been done by Mr. Wyville Thomson and Mr. James Croll in their criticism. This will be plain to every one who has read Maury's *Physical Geography of the Sea*, chapter ii., on the Gulf-stream, and the use which has been made of it by both these philosophers. Here is what Maury says:—"What is the cause of the Gulf-stream has always puzzled philosophers. Many are the theories and numerous the speculations that have been advanced with regard to it. Modern investigations and examinations *are beginning to throw some light upon the subject, though all is not yet entirely clear. But they seem to encourage the opinion.*"—How different is this cautious and reserved expression from Mr. Wyville Thomson's bold assertion that the Gulf-stream is the one natural physical phenomenon on the surface of the earth, whose origin and principal cause, the drift of the trade-winds, can be most clearly and easily traced, without giving any proof for it.—"But they seem to encourage the opinion that this stream, as all the *constant* currents of the sea, is due *mainly* to the *constant* difference produced by temperature and saltness in the specific gravity of water in certain parts of the ocean. Such differences of specific gravity are inconsistent with aqueous equilibrium, and to maintain this equilibrium these great currents are set in motion. The agents which derange equilibrium in the waters of the sea, by altering specific gravity, reach from the equator to the poles, and in their operation they are as ceaseless as heat and cold, consequently they call for a system of perpetual currents to undo their perpetual work."

This is Maury's hypothesis, by which he tries to explain not only the cause of the Gulf-stream, but of all the *constant* currents of the sea. "These agents, however, are not the *sole* cause of currents. The winds *help* to make currents by pressing upon the waves and drifting before them the water of the sea; so do the rains, by raising its level here and there; and so does the atmosphere, by pressing with more or less superincumbent force upon different parts of the ocean at the same moment, and as indicated by the changes of the barometric column. But when the winds and the rains cease, and the barometer is stationary, the currents that were the consequence cease. The currents thus created are therefore *ephemeral*. But the changes of temperature and of saltness, and the work of other agents which affect the specific gravity of sea-water and derange its equilibrium, are as ceaseless in their operations as the sun in his course, and in their effects they are as endless. Philosophy points to them as the *chief* cause of the Gulf-stream and of all the *constant* currents of the sea."

This hypothesis was offered for the purpose only of stimulating observers or thinkers, expecting thus to make a step towards some hidden truth, by proving the hypothesis wrong or by proving it right, for in either case there is generally a triumph and a step gained. Mr. Wyville Thomson's very interesting book, *The Depths of the Sea*, and several other highly valuable papers concerning the mysteries of the great deep, have certainly not disappointed Maury's expectations. There are at present more scientific observers afloat than could be expected a few years ago, when Maury wrote his *Physical Geography of the Sea*. Unfortunately, in the case of the Gulf-stream, we have not yet found the hidden truth of its origin and principal cause. Maury has demonstrated that all the existing theories were wrong, and Sir John Herschel, Mr. James Croll, and Mr. Wyville Thomson do not admit that Maury's hypothesis or Dr. Carpenter's hypothesis are right.

Still these wonderful phenomena, the constant currents, the great rivers in the sea, remain unexplained in spite of the number of collected observations, a great many of which have been most carefully made, and although the most profound thinkers have investigated this subject. It appears thus, that what is the cause of the Gulf-stream still puzzles all those philosophers who are not satisfied with a simple assertion that this or that may be the cause, and who think that it is not so most clearly and easily to be traced, as Mr. Wyville Thomson would make us believe, to the drift of the trade-winds.

"The pressure of the trade-winds," says Maury, "may *assist* to give the Gulf-stream its initial velocity, but are they of themselves sufficient to send such a stream of water all the way across the ocean, projecting by a single impress a volume of water from the shores of America to the shores of Europe, that exceeds in discharge the mighty Mississippi a thousand times? Reason teaches, and examination shows, that they are not.

"With a view of ascertaining the average number of days during the year that the north-east trade-winds of the Atlantic operate upon the currents between 25° N. and the equator, log-books containing no less than 380,284* observations on the force and duration of the wind in that ocean were examined. The data thus afforded were carefully compared and discussed. The results show that within those

* *Nautical Monographs.*—Washington Observatory, No. 1.

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latitudes, and on the average, the wind from the north-east quadrant is in excess of the winds from the south-west only 111 days out of 365. During the rest of the year, the south-west counteract the effect of the north-east winds upon the currents. Now, can the north-east trades, by blowing for less than the third of the time, cause the Gulf-stream to run all the time, and without varying its velocity, either to their force or their prevalence?"

Mr. Wyville Thomson ought to have given some reason why he answers "yes" to this question. If we look still closer to facts, and find that the constant current, before it feeds the Gulf-stream, has often to run into the Gulf of Mexico against the very strong Northers, which sweep with more force over the Gulf than ever was experienced in any trade-winds, then we should like to hear from Mr. Wyville Thomson how he can reconcile this fact with his theory.

Every sailor, stimulated by Maury's investigations, who has given, in later years, attention to the relations between winds and currents, will agree with him in thinking that the winds are not the supreme current-producing power in the sea.

"The Gulf-stream," says Maury, "sets, as it comes out of the Gulf of Mexico, and for hundreds of miles after it enters the Atlantic, against the trade-winds, for a part of the way it runs right in the 'wind's eye.' The Japan current, 'the Gulf-stream of the Pacific,' does the same. The Mozambique current runs to the south against the south-east trade-winds, and it changes not with the monsoons."

Everywhere we find abundant evidence that the trade-winds cannot be the principal cause of those wonderful warm currents in the sea, but also a great many indications pointing to the probability that both are effects of the same causes, which make air and water obedient to the same laws, fulfil each according to its properties, and the conditions in which they are placed, the duties they have to perform in the economy of nature. Why should they not assist each other in performing the manifold offices for which they were called forth to give and maintain life to the infinite inhabitants of the earth, and deck it with beauty and riches, and nevertheless to maintain an everlasting equilibrium in the conditions of the ocean and of the atmosphere?

When we see the winds and the ocean-currents working harmoniously together to fulfil their imposed task, why should then the one be called the effect of the other? Have we not equal right to call the winds effects of the ocean-currents, as these to be the effects of the winds? Is Mr. Wyville Thomson's chapter on the Gulf-stream not a better illustration of the effects of the ocean-currents upon climate, and consequently upon winds, than a demonstration that the *constant* currents in the sea derive their existence from the winds?

If we look closer to facts than to theories or speculations, have we not then the right to think that the trade-winds are as much influenced by the currents in the sea as these are influenced by the trade-winds? How otherwise can we explain the southerly limit of the south-east trade-winds being so far south above the cold current on the east side of the South Atlantic, and so near the equator above the warm-current on the west side of it? Why are the north-east trade-winds drawn more easterly in the Carribean Sea, and why are they on the same parallel more northerly on the east than on the west side of the North Atlantic?

Would there not be a continual harmonious action between air and water if the whole earth was covered with water, and do we not see the fearful consequences when this harmony is disturbed by the influence of the land? When, for instance, by the action of the super-heated land, the trade-winds are drawn from the sea out of their usual channels of circulation, in which they did co-operate with the ocean-currents, then the harmonious action between air and water ceases; the sweet and pleasant aspect of the scenery disappears; peace and tranquility are destroyed, and we see everywhere hostility, till at last, when the disturbance reaches its greatest development, cyclones and hurricanes, or typhoons, run along the paths of the warm currents to restore with wild violence the disturbed equilibrium and prepare the return to harmonious action.

Is the sea, its vapour and its ice, and are the currents, which are the consequences of it, not necessary for the circulation of the atmosphere? Why should the winds not be necessary for the circulation of the ocean, although not more than vapour or ice are necessary for the circulation of the atmosphere?

He who looks upon the currents in the sea as the effect of the pressure of the winds only, will never be able to explain why the warm rivers in the sea continue their regular course while the monsoons prevail blowing in opposite directions.

The sun, heat and cold, are the principal sources of motion. The only thing we have to do is to observe the motions of sea and air, their temperatures and densities, as has been done with so much intelligent care in the 'Lightning' and the 'Porcupine,' and will be done in the 'Challenger,' and by the thousands of less careful observers who have been stimulated by Maury's publications; and those facts, when grouped together in sufficient numbers and catechised with reverence by a mind unbiassed by theories and speculations, will themselves reveal their cause, or place in our hands the clue to such explanations as man is permitted to comprehend. That is Captain Maury's view, and it is, I think, the only one from which we may expect that at last the hidden truth will be brought to light.

If we adopt, notwithstanding all the circumstantial evidence against it, the theory that the Gulf-stream derives its existence from the trade-winds, the investigations on this subject lose their interest; but if we admit that it does not, a wide and very interesting field of research is spread before us. This is what Maury has done by offering his hypothesis about the Gulf-stream, after having demonstrated that all the existing theories did not agree with the facts in hand. Those who do not agree with him are obliged, in the first place, to demonstrate that their trade-wind theory is right, and that it satisfies not only the case in hand, but that it will serve also to explain the greatest number of other known facts. Then, and only then, shall we be able to judge of the comparative value of the one and the other hypothesis.

But it will be necessary to show that the trade-winds, far from being in a great measure prevented from pressing upon the sea by the continually upraising of vapour from its surface between the tropics, act so efficaciously upon it that a constant current is produced, without creating a high sea or a

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long swell, which are generally found to be consequences of a heavy pressure from winds upon the sea.

In the Carribean Sea, where the constant current is already well developed, we seldom find a long swell or high sea unless a hurricane has gone over it. *Curaçoa*, one of the Leeward Islands, has never been touched by a hurricane, but the people on the north coast know, from the wild roar of the breakers, when there is one in the Carribean Sea; yet after a few days the sea regains its usual smoothness.

In the westerly winds of the southern hemisphere, which blow with the force of a gale between north-west and south-west nearly all the year round, and where we find a sea or a swell proportionate to the fury of the winds, where is there the much stronger current caused by those more powerful winds than the gentle trade-winds, if these are able to create such a tremendously powerful current as the Gulf-stream?

By what winds are the ice-bearing currents driven to lower latitudes, and icebergs against a head wind? Why is it that the monsoons, created by causes which do not influence the sea, have so little influence upon the constant warm currents? And if the trade-winds make those constant currents, where are the constant currents created by the monsoons or by the much stronger anti-trade-winds?

If all those and a great many other phenomena can be satisfactorily explained by Mr. Wyville Thomson, as we must presume from his bold assertion, and if he is able to show that his trade-wind theory is right, or that another hypothesis is better and serves to explain a greater number of facts, Maury would have been the first to give up his own explanation. This has always been his rule of conduct, and to it, his mind being unbiassed by theories and speculations, the great success of his labours is due.

JANSEN.

THE MODOC INDIANS.

IN the summer of 1865, I accompanied, in the course of my scientific pursuits, a troop of cavalry across the Cascade mountains in Oregon, near the headwaters of the Willamette, into the country east of the range mentioned. These troops were to escort the then superintendent of Indian affairs for Oregon to the Snake country, with a view to attempt to make a treaty of peace with the Snake Indians, who had then been at war with the whites for more than eight years. After crossing the mountains by a perilous and difficult path, we entered a desert country thinly scattered with the *Pinus contorta*, a shrubby species of pine, but dry and barren except along the course of a few streams, which the melting snow of the mountains sent to meander for a short distance through it, but soon to be dried up in the cavernous volcanic soil. Passing within sight of the Cascade range, we reached Fort Klamath, embosomed in a valley among the mountains, then struck east to Spragues River 50 miles from the fort, met Pah-nin-e, the Snake Chief, transacted our business, and then, to the number of five, started, unescorted, south-east to the settlements in Western Oregon, through the Modoc country.*

The Indians inhabiting the country we rode over were scattered bands of mountain tribes, chiefly of a low grade, approaching to the "diggers" of the California Sierras, but rather more elevated in the social scale owing to their being in possession of horses and some fire-arms. Treacherous and cunning, they bear a bad reputation, and though there was no immediate danger, yet we were forced to watch them closely. The Klamath Lake Indians are about equally divided, as is also their land, by the state line (42.° N. latitude), and the Modocs and their lands are mostly in California. The tribes inhabiting the country lying west of the Sierra Nevada Mountains and south of the Siskiyou Mountains to the confluence of the Scott's and Klamath Rivers are as follows:—The Hamburg Indians, known in their language as T-ka, inhabit the district immediately at the mouth of Scott's River, called by them Otte-tie-e-wa. The Scott's Valley Indians (or Id-do-a), inhabit Scott's Valley above the Cañon. The Yreka (a misnomer for Yeka-Shasta Butte) Indians, called in their language the Ho-te-day, inhabit that part of the country lying south of Klamath River, and west of Shasta River. The Shasta (or Wee-o-how) Indians—the native name meaning "stone house," from a large cave in the great lava-beds in their country, where the Indians often conceal themselves and their plunder—occupy the land east of Shasta River and south of the Siskiyou Mountains, and west of the lower Klamath Lake. All of these Indians speak the same language, and were formerly under one chief (who lived in Scott's Valley) and subchiefs; but for some years they have been under separate chiefs, the former royal family having become extinct by sickness and other casualties about the time the whites began to first enter the country. Lying immediately east are the Indians whom I have already spoken of, the Klamath Lake Indians, known in their language as the Okshee, who inhabit the country about the Klamath Lakes, and east about half-way to the Goose Lake, to Wright Lake, and south to a line running about due east from Shasta Butte. Then the Modocs (or Moadoc, as the word is pronounced) called in their language the Ok-kow-ish, inhabit the Goose Lake country, and are mostly within the state of California. These and the Klamath Lake Indians speak the same language, though under several chiefs. The Modocs are under old Skontian or Skonges as head chief, Skilte-hon-ges, and other smaller chiefs; and the Klamath Lake Indians under our pusillanimous aquaintance La-lake and other smaller chiefs. One of the Modoc Indians, Captain Jack, has visited San Francisco, and apparently not benefited greatly thereby.

The word *Modoc* is a Shasta Indian word, and means all distant, stranger, or hostile Indians, and became applied to these Indians by white men in early days by hearing the Shastas speak of them as such. The range of the Siskiyou Mountains, known in their language as the Mac-ki-a, forms the northern limits of the country of most of these tribes. The Klamath Lake and Modoc Indians were stated in an official Report, published in 1864, to number about 1400 warriors. Transatlantic official Reports are, however, like some similar documents elsewhere, not always markedly distinguished by the cardinal virtue of truthfulness; and official statutes of the Indians, by uncontradicted universal opinion, are asserted to invariably lie. I do not believe the Klamaths could now muster 300 warriors; and there are said not to be over forty

* *Proceedings of Royal Geographical Society*, 1866.

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